1851MNRAS..11..147D

in time will be confined absolutely to the hour-angles, and thus the injurious effects will be very much simplified, and may perhaps be effaced by further operations."

On the Measurements of Azimuths on a Spheroid.

By Lieut. A. R. Clarke, R.E.

The author commences his paper with the following words:—

" It is generally assumed in geodetical calculations, that the sum of the reciprocal azimuths of two stations on a spheroid is the same as if the stations were on a sphere and had the same latitudes and difference of longitude. This is based on Dalby's geometrical proof, that the difference between the two sums in question is very small if the stations be equally elevated above the surface. It is not, however (nor can be geometrically), shown that this difference is not greater than the probable error of observation, and therefore it may be useful to find an expression for this small difference in terms of the latitudes and longitudes of the stations, in order to see whether it may be in any case greater than the probable errors of observation, and large enough to be worth taking into account."

The author then investigates by accurate formulæ of analytical geometry, as applied to the co-ordinates of points which satisfy the spheroidal equation, the expressions for the tangents of the angles of reciprocal azimuths of two stations, and forms the accurate expression for the tangent of the sum of azimuths, and for the tangent of the excess of this sum above the sum of corresponding spherical azimuths. The expression is then cautiously reduced, and it is found, at length, that the value of this excess is insensibly small; amounting only to $0''\cdot000003 \times m^2 n$, where m is the number of degrees in the distances of the stations, and n the number of degrees in the difference of latitude. Then the influence of difference of heights is computed; and it is shown that, though (in cases which may arise in practice) it is greater than what has just been found, yet that it also will be insensible.

At the close of the meeting, Mr. De Morgan made some remarks upon the Gregorian Calendar, as an instrument for determining the moon's phases with sufficient accuracy to settle the question of *moonlight*. Having been led to examine it in this point of view, for the purposes of a collection of almanacs which he is preparing for publication (and which has since been published) he found that it may be made to give the day of new moon or of full moon right in three cases out of five, and with an error of only one day in almost all the other cases; the error of two days occurring only about once in 120 results. In order to obtain this amount of accuracy, the rule is:—Use the Gregorian epact to

Downloaded from http://mnras.oxfordjournals.org/ by guest on September 1, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System

1851MNRAS..11..147D

determine full moons, and that epact increased by 1 to determine new moons; both with the well-known epact-table which appears in all extensive works or articles on the calendar.

The reason of this rule is as follows:—Clavius constructed the Gregorian Calendar expressly in such manner that the moon of his calendar should be always, as well as it could be managed, one day younger than the moon of the heavens; the object being, that the fourteenth day, by which Easter is determined, should follow the day on which the Jews keep the Passover. And as this was done with good success, it follows that one day added to the age of the calendar moon at the beginning of the year, (that is, to the Gregorian epact), gives the same degree of success to the calendar, as a means of determining the day of astronomical new moon.

If the chronological full moon had been correctly laid down, this same addition of 1 would have been equally successful as to the full moon. But the *chronological* full moon is on the *fifteenth* day of the moon. Now, half a lunation being, on the average, 14¾ days, it follows that, unless the mean new moon happen in the first quarter of its day, the mean full moon is on the *sixteenth* day; so that, in the long run, the sixteenth is the proper day three times out of four. Hence there is no occasion to increase the epact by 1, in order to determine the astronomical full moon; which is as correctly determined as the calendar will do it, by applying the existing epact to the existing hypothesis of the fifteenth day.

The preceding conclusions as to the probability of truth and error were obtained from the nineteen years 1828–1846; the following are the results for 1851, 1852, and 1853:—

New Moon.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1851	2	1	2+	1,30+	30	28+	28	26	25	24	23	22
1852	21	19+	21−	19	19	17	17	15	14−	13	12−	11
1853	10−	8	10−	8	8	6	6	4+	3	2	1,30	30
Full Moon.												
1851	17	16	17	16−	15	14−	13	12−	10	10	8	8
1852	6+	5	6	5−	4−	3−	2−	1−30−	29−	28−	27−	26
1853	25	23	25	23	23−	21	21−	19−	18−	17	16−	15

Here are exhibited the days of new and full moon by the calendar: when + or — follows the date, the real day is the day after or the day before. And though in this period of three years the errors of the full moon much exceed in number those of the new moon, there is no such excess in the long run. The nineteen years 1828–1846 gave 140 cases of new moon true to the day, and 141 cases of full moon.

London: Printed by G. Barclay, Castle St. Leicester Sq.

Downloaded from http://mnras.oxfordjournals.org/ by guest on September 1, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System